Characterization of the vertical structure of the atmosphere using ground-based remote sensing (II)

C. Yballa Hernández Pérez

PROJECT 3

Training in remote instrumental techniques (ground-based remote sensing) for detection and study of reactive gases and atmospheric aerosols

Tutor: Dr. Emilio Cuevas Agulló
Supervisors: Dr. Alberto Berjón Arroyo, Dr. Silvia Alonso Pérez and Dr. Emilio Cuevas Agulló

3rd June, 2013

Contents

- Introduction
  - Lidar
  - Ceilometer
- Maintenance, calibration and evaluation of data (MPL-3 and CL51)
- Publications, congress communications, work in progress and future

Introduction

Aerosols

Diverse sources of aerosols: **natural** and **anthropogenic**

Aerosols affect climate, mainly in two ways

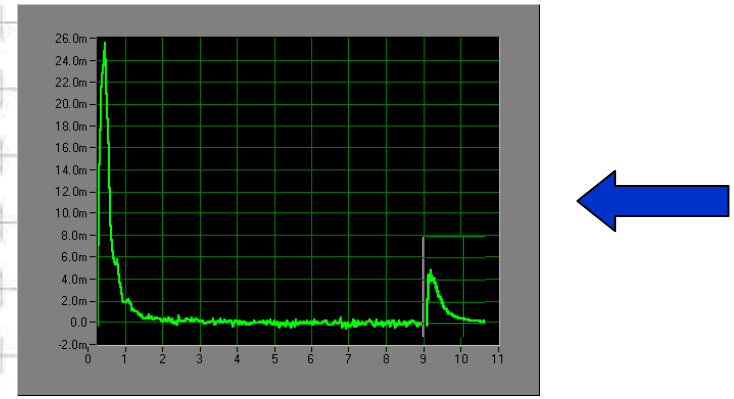
Direct: scattering and absorbing the solar and terrestrial radiation

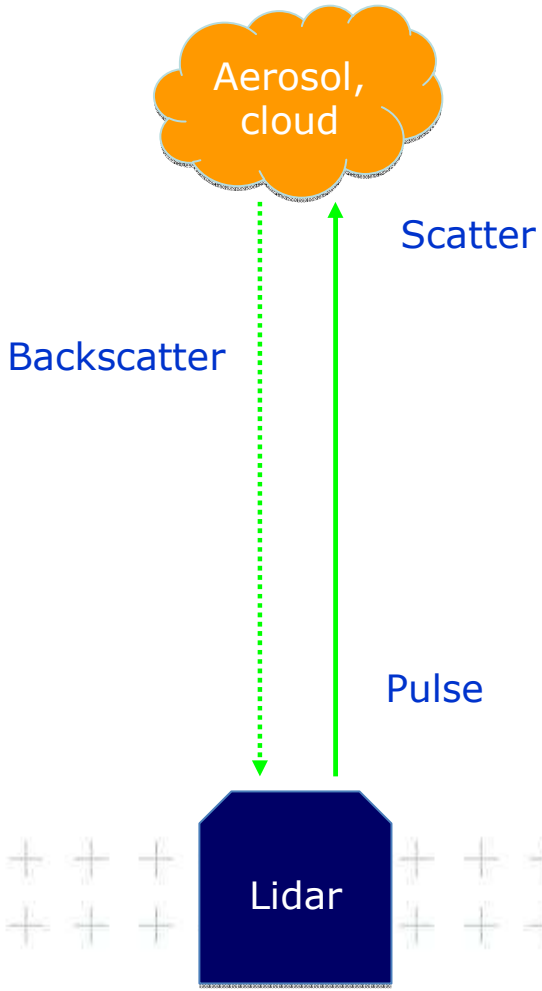
Indirect: altering microphysical properties and lifetime of clouds

Aerosol vertical distribution is an important parameter

Introduction

- Lidar ⟶ capable of providing vertical profiles of aerosol and cloud structure





-Lidar

Micro Pulse Lidar (MPL-3)

- ✓ **CIAI (AEMET) and INTA co-manage the MPL-3**
- ✓ **523.5 nm**
- ✓ **7 µJ**
- ✓ **'eye-safe'**

http://mplnet.gsfc.nasa.gov.

www.lidar.es/spalinet/es/

GALION www.wmo.int/gaw/**galion**/index.html

-Ceilometer Vaisala CL51

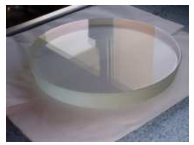
VAISALA

- ✓ Compact and robust lidar system
- ✓ Operates in extreme weather conditions
- ✓910 nm
- ✓ 3 µJ
- ✓ 'eye-safe'

Maintenance, calibrations and evaluation of data, MPL-3

Maintenance

- ✓ Temperature control : laser, telescope, detector, location…
- ✓ Humidity control
- ✓ Cleaning of optics
- ✓ Daily checking list



10%

Calibrations

- ✓ Darkcurrent (monthly)
- ✓ Afterpulse (monthly)
- ✓ Overlap (twice a year)

20%

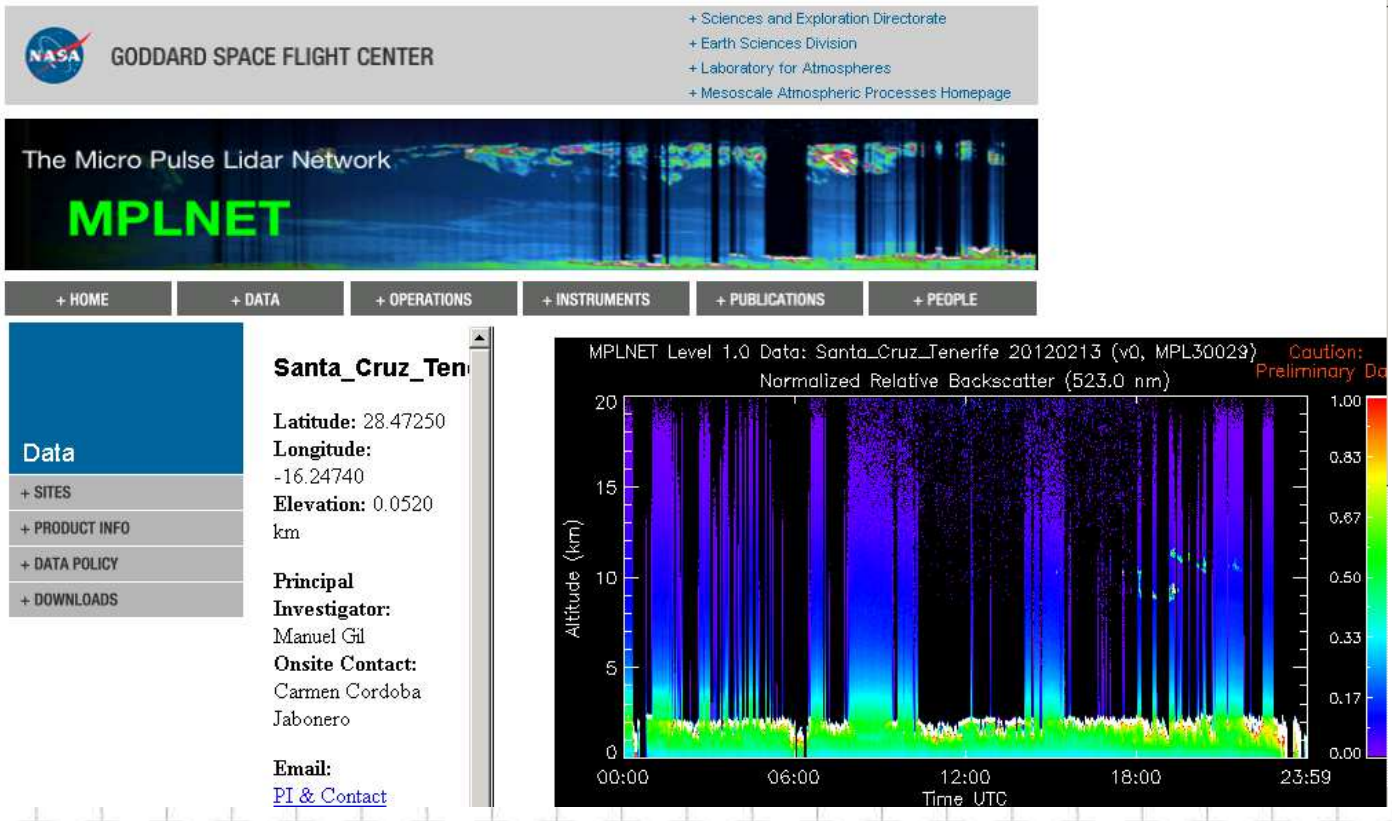
Data evaluation

- ✓ Calibrations
- ✓ Measurements

70%

Maintenance, calibrations and evaluation of data, MPL-3

Sending daily files of Lidar data to MPLNET



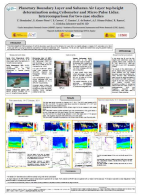
http://mplnet.gsfc.nasa.gov/dat.htlm

Maintenance, calibrations and evaluation of data, Vaisala CL51

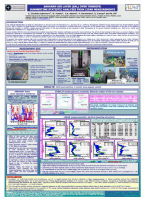
Maintenance	✓ Overall control of the instrument ✓ Cleaning of optics ✓ Daily checking list	40%
Calibrations	**X**	
Data evaluation	✓ Measurements: height of clouds, BL, aerosols	60%

Publications and Congress Communications, 2012 (1/2)

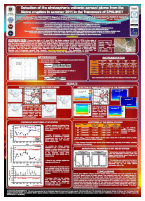
EAC-2012
Granada
European Aerosol Conference
2-7 Sept 2012



Hernández, Y., S. Alonso-Pérez, E. Cuevas, C. Camino, J. de Bustos, A.J. Gómez-Peláez, R. Ramos, C. Córdoba-Jabonero and M. Gil, Planetary Boundary Layer and Saharan Air Layer top heightdetermination using Ceilometer and Micro Pulse Lidar. Intercomparison for two case studies, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September, 2012.



Córdoba-Jabonero, C., D. Toledo, J.A. Adame, Y. Hernández, E. Cuevas and M. Gil, Saharan Air Layer (SAL) over Tenerife: Summertime statistic analysis from lidar measurements, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September , 2012.



Guerrero-Rascado, J.L., J.A. Bravo-Aranda, F. Wagner, C. Córdoba-Jabonero, F. Molero, D. Lange, M. Granados-Muñoz1, J. Preißler, D. Toledo, A.J. Fernández, M. Sicard, F. Navas-Guzmán, Y. Hernández, A.M. Silva, M. Pujadas, A. Comerón, S. Pereira, F. Rocadenbosch, and L. Alados-Arboledas, Detection of the stratospheric volcanic aerosol plume from the Nabro eruption in summer 2011 in the framework of SPALINET, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September, 2012.

Camino C., S. Alonso-Pérez, E. Terradellas, S. Rodríguez, A.J. Gómez, P. M. Romero-Campos, Y. Hernández, S. Basart, J. M. Baldasano and E. Cuevas, An empirical relationship to estimate mineral dust concentration from visibility observations, European Aerosol Conference 2012 (EAC 2012), Granada (Spain), 2-7 September, 2012.

Publications and Congress Communications, 2012 (2/2)

World Meteorological Organization
Organisation météorologique mondiale

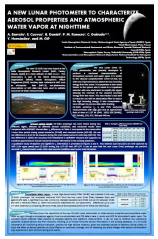
Secrétariat
7 bis, avenue de la Paix – Case postale 2300 – CH 1211 Genève 2 – Suisse
Tél.: +41 (0) 22 730 81 11 – Fax: +41 (0) 22 730 81 81
wmo@wmo.int – www.wmo.int

Weather • Climate • Water
Temps • Climat • Eau

TECO-2012

WMO TECHNICAL CONFERENCE ON METEOROLOGICAL AND ENVIRONMENTAL INSTRUMENTS AND METHODS OF OBSERVATION

Brussels, Belgium, 16-18 October 2012



A. Barreto, E. Cuevas, B. Damiri, P.M. Romero, C. Guirado, Y. Hernández and M. Gil, A new Lunar Photometer to characterize aerosol properties and atmospheric water vapor at nighttime,WMO Technical conference o meteorological and environmental instruments and methods of observation, (TECO-2012), Brussels (Belgium), 16-18 October 2012.

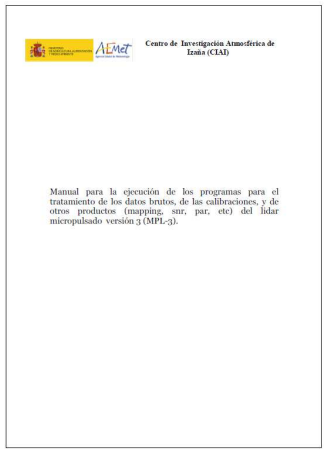
Barreto, A., E. Cuevas, B. Damiri, C. Guirado, T. Berkoff, A. J. Berjón, Y. Hernández, F. Almansa, and M. Gil, A new method for nocturnal aerosol measurements with a lunar photometer prototype, Atmos. Meas. Tech. Discuss., 5, 5527-5569, doi:10.5194/amtd-5-5527-2012, 2012.

Work in progress (1/3)

- Reprocessing of lidar data series ⟶ new algorithm

  - Calibrations: darkcurrent, afterpulse, overlap
  - Raw signal
  - Normalized-Relative-Backcattter Signal
  - Parameters: temperatures, energy,…
  - Signal to noise ratio
  - Mapping

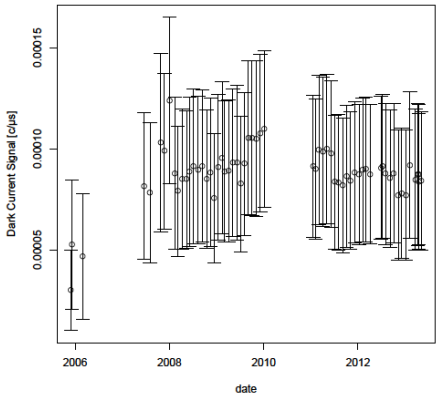
- Preparation of a protocol to process lidar data

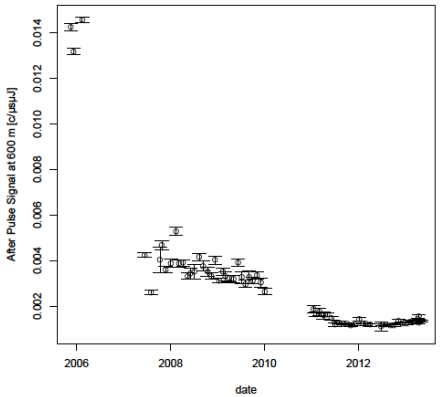

Centro de Investigación Atmosférica de Izaña (CIAI)

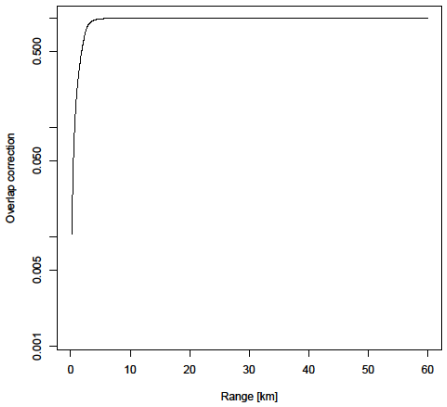
Manual para la ejecución de los programas para el tratamiento de los datos brutos, de las calibraciones, y de otros productos (mapping, snr, par, etc) del lidar micropulsado versión 3 (MPL-3).

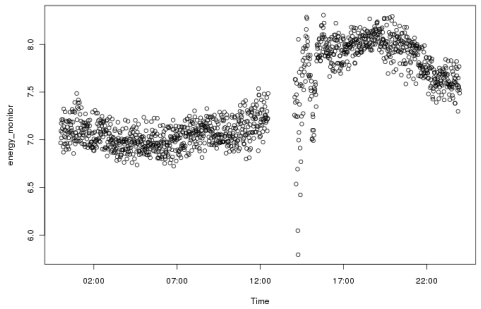
Work in progress (1/3)

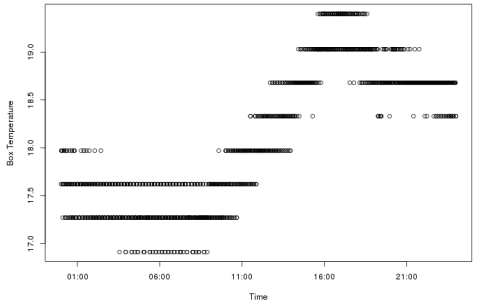
- Examples

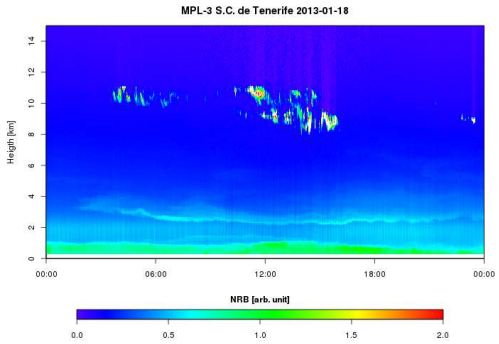






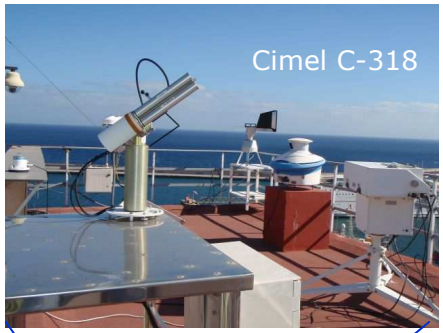






Work in progress (2/3)

- Inversion algorithm (Fernald 1984; Klett ,1985)



$$P_{NRB}(r) = C\left(\beta_M(r) + \beta_P(r)\right) e^{-2\int_0^z \sigma_M(r')dr'} e^{-2\int_0^z \sigma_P(r')dr'}$$

- 3 unknowns
- To solve the problem:

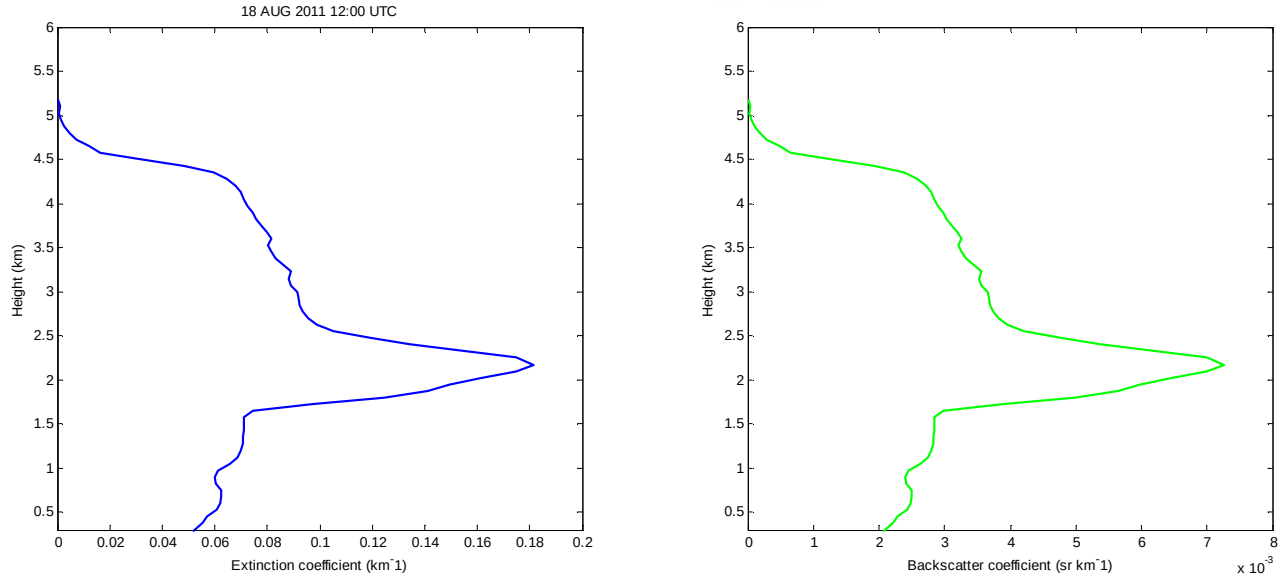
Zref → ~~C~~

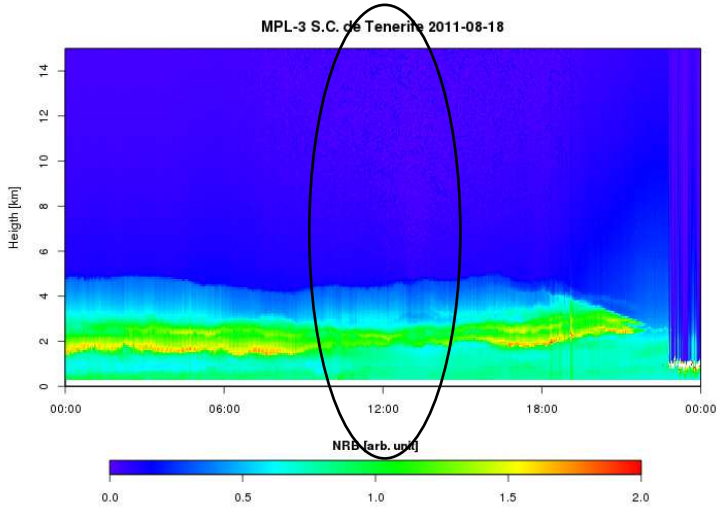
LR=α/β

$AOD_{MPL} \approx AOD_{AERONET}$

Work in progress (2/3)

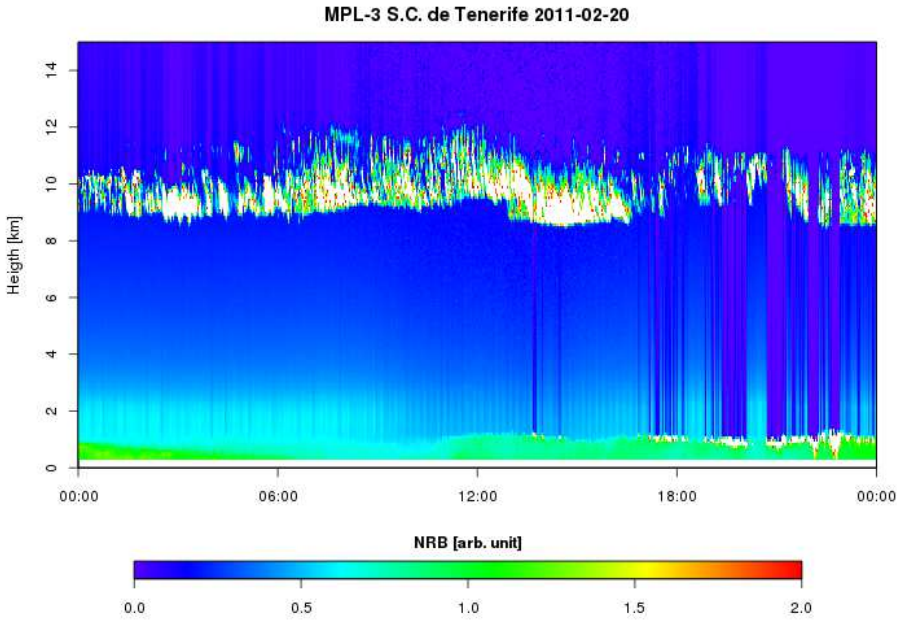
- Examples

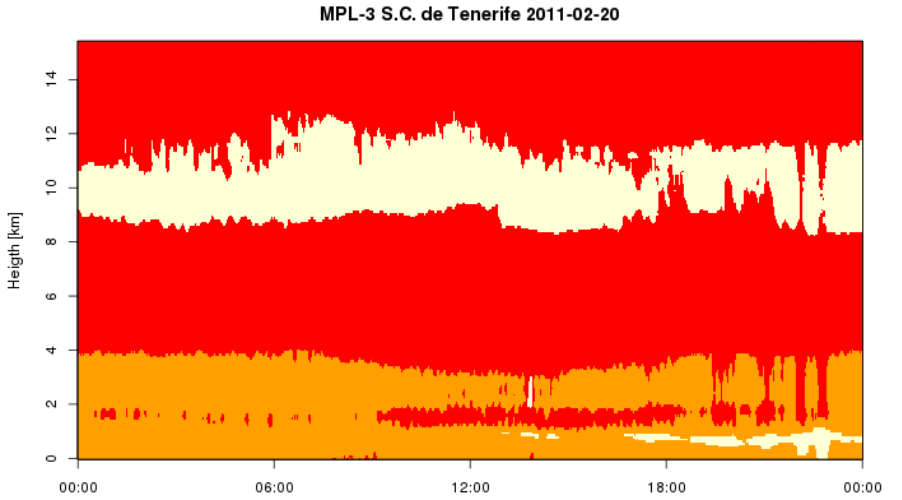




Work in progress (3/3)

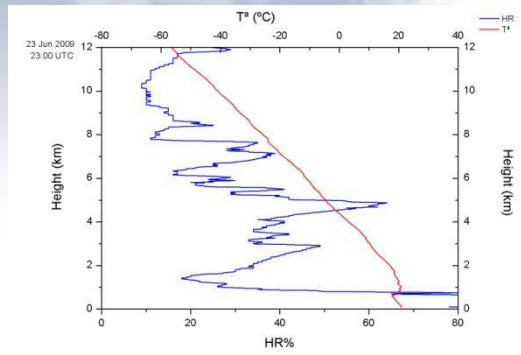
- Automated algorithm ⟶ detection of layers (cloud-aerosol)

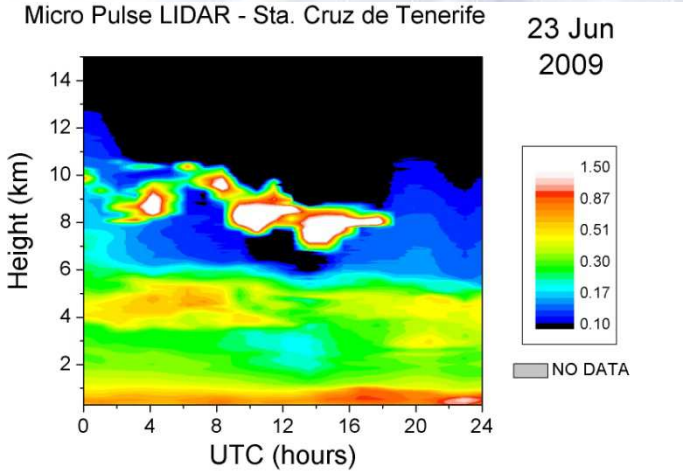


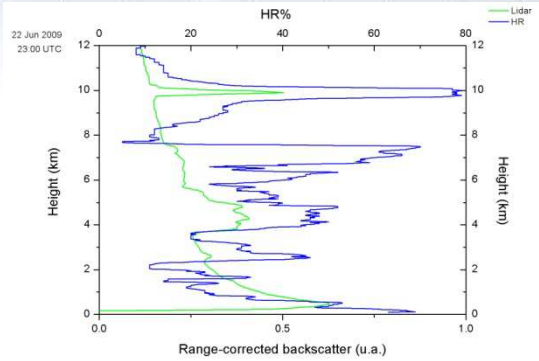


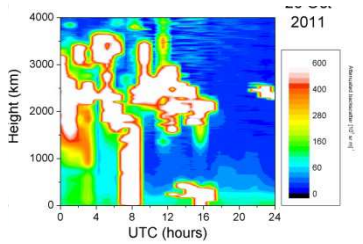
Future Work

- Determine aerosol optical properties at night ⟶ MPL-3+lunar photometer
- Estimation of errors in lidar inversion
- Climatology of the top height of the Saharan air layer
- Determine the top height of the Marine boundary layer (comparison between MPL-3 and CL51)
- Thesis on 'Characterization of the Saharan air layer with Lidar and ceilometer', Directors : Dr. Silvia Alonso Pérez and Dr. Emilio Cuevas Agulló









Thank you for your attention